Attachment No. 1
N00173-00-R-HA08

Specifications for Photolithographic Mask Aligner System

Section 1. General Requirements

1.1 Scope. This specification describes the minimum technical requirements and the minimum acceptable performance standards for a photolithographic mask aligner to be installed by the contractor at the Naval Research Laboratory (NRL), Washington, D.C. This system will be used by NRL personnel to transfer patterns from a mask to a wafer or substrate using contact photolithography. The mask aligner will be placed in a multiple-user facility and must provide ease of operation and not interfere with the safety of those in the facility.

1.2 Installation Site. The system will be installed in Bldg 3, Naval Research Laboratory(NRL), Washington, D.C. 20375, at a specific location to be designated by the NRL'S Technical Manager (TM). The laboratory utilities will include 115 and 208 volts alternating current (VAC), single phase, 60 Hertz (Hz) electrical power and vacuum, compressed air and compressed dry nitrogen within a Class 1000 clean room. The contractor must install the system in a manner consistent with typical Class 1000 clean-room operating procedures.

1.3 Description and Primary System Components. The photolithographic mask aligner is to be used to transfer patterns from a fused silica mask to a substrate using contact photolithography. This process utilizes deep ultraviolet (DUV) light to define a pattern in photoresist that, with subsequent processing, allows the construction of 2 -dimensional devices with submicrometer resolution. This system will be used in a clean-room environment by a restricted group of trained operators. This specification is organized by describing the three major components of the mask aligner system: 1) a mechanical stage supporting the sample and mask and allowing alignment to be carried out between the two, 2) an optical exposure system capable of directing DUV radiation to the sample for a fixed and programmable period of time, and 3) a topside microscope and camera system to be used during alignment of the sample to the mask. The requirements for each of these components follow.

Section 2. Mechanical Subsystem Requirements

2.1 Sample Size. The mask aligner must be capable of aligning and exposing wafers having diameters of 2 inches, 3 inches and 100 millimeters with thickness ranging from 0.010 - .050 inches. The system must also be capable of aligning and exposing 150 millimeters diameter, 0.030 inch thick wafers with proper fixtures.

2.2 Mask holder. The system must be capable of supporting 4-inch and 5-inch square masks and, with minimal additional components, masks up to 7-inch square. Mask loading and unloading must be simple allowing a minimum of instrument downtime.

2.3 Wafer-Mask Alignment. The system must allow relative mask-sample motion in x,y,z and θ directions. (The x-y plane is defined as the plane of the mask; the z-direction is normal to the mask; θ is the angle measured from the x-axis in the x-y plane.)

Wafer-mask minimum motional range, x direction: ± 10 mm (20 mm range)
Wafer-mask minimum motional range, y-direction: ± 5 mm (10 mm total)
Wafer-mask minimum motional range, z-direction: 0-300 micrometers, minimum
Wafer-mask θ range: ± 5 degrees (10 degrees total)

Position of the sample or mask in x, y, and θ directions is to be precision micrometer-driven; chessman-type or joy-stick positional systems are not acceptable.

2.4 Wedge-error compensation. The system must automatically compensate for mask/sample non-planarity (also known as wedge-error). Ball and calotte systems of obtaining planarity are not acceptable.

2.5 x-y-θ Mechanical Resolution. The system must be capable of positioning a wafer relative to the mask to a resolution of 0.15 micrometer or less.

2.6 X-y Shift Z-Movement. The shift in the x and/or y directions (relative to the mask) occurring as a result of motion of the wafer over the full range of z must be less than 0.1 micrometers, absolute.

2.7.1 Contact Modes, Description. The contact mode refers to the nature of the wafer/sample contact during exposure. *Soft contact* mode applies a controllable and settable pressure to the mask-substrate interface through mechanical means. *Hard contact* duplicates the soft contact mode but in addition applies a settable pressure of gas behind the mask and/or wafer causing a compressive force between the mask and wafer. *Vacuum contact* is achieved by applying a vacuum to the interface region between the mask and substrate. *Proximity* mode refers to a user-programmable (or settable) distance between the wafer and substrate.

2.7.2 Contact Modes – Requirements. The instrument is to provide soft, hard, vacuum and proximity contact exposure modes having the following specifications.

2.7.2.1 Soft/hard contact minimum pressure range: 0.02 – 1.0 N/cm^2, adjustable.
2.7.2.2 Vacuum contact: adjustable from ambient pressure to 200 mbar absolute.
2.7.2.3 Proximity mode wafer-mask gap range: 1 – 100 micrometers, adjustable in 1 micrometer steps with wedge-error compensation active.

2.8 Flat alignment. The stage must be capable of aligning the wafer flat to a mask edge to within ±2 degrees.

Section 3. Optical Subsystem Requirements.

3.1 General Description. The optical subsystem directs deep ultraviolet radiation from a source to the sample under time-programmable control. The mask aligner will be attached to an excimer laser provided by a third party that produces 193 nanometer wavelength radiation. The optical subsystem must accept this radiation, process it optically via expanding and homogenizing lenses, and direct the radiation to the wafer.

3.2 Input beam characteristics. The excimer laser to be used as a DUV light source is the GAM EX100/1000. It has the following beam characteristics

Wavelength: 193 nanometers
Max average power: 35 Watts
Pulse length: 15-20 nanoseconds
Beam size: 9 x 3-5 millimeters
Beam divergence: 0.4 x 0.8 milliradians

The laser will be mounted directly to the mask aligner with no reflecting mirrors or beam conditioners.

Refer to GAM Laser, Inc., Orlando, FL (www.gamlaser.com) for more details.

3.3 Laser interface. The mask aligner system must provide an electronic digital control signal to the laser system to initiate and halt the firing of the excimer laser. The digital control signal must be settable in relation to the exposure time of the laser.

3.4 Exposure time range/resolution. The minimum exposure time range is 0 – 999 seconds and programmable in intervals down to 0.1 seconds.

3.4 Optical wavelength compatibility. The optical components of the mask aligner must be compatible with 193 nm ultraviolet radiation.

3.5 The system must have field-demonstrated capability of interface between the mask aligner and an excimer laser system. Beta-test systems are not acceptable.

3.6 Exposure area uniformity. The system must provide a 4 inch diameter area of uniform intensity. The intensity variation in this region is to be less than ± 5% from nominal. The system must be capable of exposing a 6 inch diameter wafer.

3.7 Print resolution. The system must be capable of providing 200 nm line-space print resolution. A demonstration of print resolution is required during installation and test of the instrument.

3.8 Safety. The system must meet industry and governmental guidelines for safety and prevention of exposure to 193 nanometer radiation. Specifically, but not exclusively, the system must follow guidelines enumerated by SPAWAR INST 5100.12B and ANSI Z136.1.

Section 4. Microscope Requirements

4.1 General. The microscope subsystem will allow the operator to visually align the wafer to the mask. The system must display the alignment features on a video monitor and provide simultaneous imaging and display of at least two points on the mask. It must provide screen capture to a Windows-based personal computer and electronic overlay of mask alignment features to wafer alignment features to assist in the alignment process. File capture formats must include the Tagged Image File Format (TIFF).

4.2 Objective magnification range. The microscope is to have a minimum of three, turret-mounted objectives for sample imaging. The lowest image magnification must be less than 200X; the highest image magnification must be greater than 750X.

4.3 Working distance. The objective lenses must operate with a minimum 7 millimeter working distance.

4.3 Split field objective separation. The objectives must be capable of variable separation between 32 – 160 millimeters center-to-center. The microscope – stage system must also be capable of precisely aligning to the wafer flat.

Section 5. Additional support items.

5.1 Vibration isolation table. A vibration isolation table is required that will conveniently support the mask aligner system. The table is to be air-operated capable of operation with 80 psi (pounds per square inch) air.

5.2 Intensity meter. The vendor shall supply a calibrated intensity meter and sensor capable of measuring 193 nm wavelength radiation intensity at the wafer plane. The sensor must be capable of measuring light intensity over the central 4 inch exposure region at the wafer plane.

5.3 The screen capture computer must be configured with a 10 Base-T Ethernet adapter card (3COM 3C509 or equivalent.)

5.4 Laser-mask aligner installation and test. The vendor will provide physical interface and operational testing of the excimer laser to the mask aligner. Execution of this item will be contingent on demonstrated operation by Naval Research Laboratory personnel of the excimer laser prior to mask-aligner installation.

5.5 Training. The vendor will provide training on the operation of the instrument to up to five researchers upon installation at NRL, the mask aligner-laser system.

5.6 Warranty: Offerors shall offer the Government at least the same warranty terms, including offers of extended warranties, offered to the general public in customary commercial practice.

5.7 Documentation: NRL requires two (2) copies of an operator manual for the photolithographic mask aligner system. The contractor must provide instructional and maintenance manual that includes schematics and diagrams.

Section 6. Options

6.1. Uninterruptible power supply. The vendor will provide an uninterruptible power supply capable of supporting the mask aligner with electrical power for a period of 20 minutes.

6.2 Flow hood. The vendor is to supply a flow hood that will provide a locally clean environment to Class 100 or better. Input air will be from the laboratory Class 1000 air supply.

6.3 150 mm Exposure Optics. The vender will configure the system to for ±5% uniformity over a six inch diameter.